HYDROGENICS

Changing power ...Powering change

Marketing and Commercialization Challenges for PEM Fuel Cells

Fuel Cells in California:
Opportunities and Barriers
California Energy Commission
May 31, 2006

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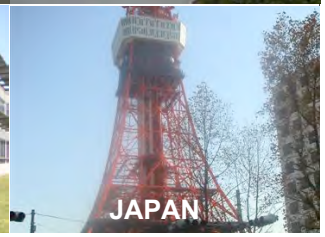
Agenda

- Introduction to Hydrogenics
- Commercialization Challenges
- How the CEC Can Help
- Closing Remarks

Company Profile

- **Established in 1995**
- **Three business units**
  - OnSite Generation
  - Power Systems
  - Test Systems
- **Global Presence**
  - Canada: Toronto & Vancouver
  - Belgium
  - California
  - Germany
  - Japan
- **NASDAQ (HYGS) & TSX (HYG) listed**
- **270 employees**
- **87 patents awarded; 550 pending**



HyPM® Fuel Cell Power Module Technology

End Plate

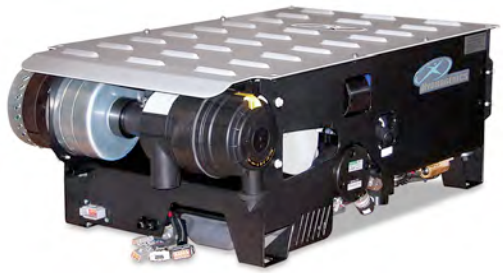
MEA (Membrane Electrode Assembly)

Flowfield Plate

Humidification

Air delivery

Fuel delivery



Coolant Pump

Air Flow Meter

Controls

Air Filter

FC Stack Subsystems

FC Power Module Subsystems

HyPM Fuel Cell Power Products

Range of Fuel Cell Power Products targeting specific needs

- Fuel cell Power Modules for OEMs - 8, 12, 16, 65 kW
- DC Power Solutions – Fuel cell power module integrated with power conditioning packages to deliver specific nominal voltages - 24, 36, 48, 72 Volts, suited to diverse end user needs
- Fully integrated Fuel Cell Power Packs consisting of fuel cell power module, thermal management, power conditioning, energy and hydrogen storage for end user applications

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Fuel Cell Applications

Commercialization Challenges

- Cost
- Durability/Reliability
- Hydrogen Storage/Infrastructure
- Codes and Standards
- Public Outreach and Education

More Challenges

- Long sales cycles
- Cost sharing requirements
- OEM missing link
- Iterations on technology required
- Limited end user experience – unease about technology
- Cash burn

How CEC Can Help

- Cost
  - Team up with other funding agencies or with markets where the value proposition makes sense:
    - Military
    - Back-up power
  - Look at novel approaches to reduce amount of fuel cell power required, e.g. battery dominant hybrids
  - Include back-up power applications in Self-Generation Program
- Durability/Reliability
  - Continue demonstrations to generate field data
  - Fund R&D work in these areas
- Hydrogen Storage and Infrastructure
  - Fund R&D work in area of hydrogen storage
  - Infrastructure
    - Install hydrogen stations for fleets that allow access to third parties
    - Build infrastructure to match vehicle deployment

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How CEC Can Help

- **Codes & Standards**
  - Allow composite tanks as ground storage, and/or expedite ASME to establish the code

- **Public Education and Outreach**
  - Continue to have demonstrations of near-commercial products
  - Endorse early fuel cell markets such as back-up power and forklifts (similar to Military first using GPS before civilian usage)
  - Consider Hydrogen Village concept, to link with Hydrogen Highway initiative

How CEC Can Help

- **Long Sales Cycles**
  - Issue RFQ/RFPs with pre-approved funds
- **Cost Sharing Requirements**
  - Fully fund projects, or combine funding sources to establish a fully funded project
- **OEM Missing Link**
  - Show OEMs that there is interest by participating in a demonstration, or by committing to purchase if all technical and commercial requirements are met
- **Iterations on Technology Required**
  - Increase rate of iterations by funding demonstrations or R&D work
- **Limited End User Experience** – unease about technology
  - Be a user of the technology; be a reference account

Summary

- Fully fund demonstrations, or organize a set of funding agencies (e.g. State + Military) to fully fund a project
- Purchase a commercialized fuel cell product, e.g. APC/HYGS, Plug Power, Idatech
- Consider path of commercialization in funding decision - include funding of applications that will lead to an ultimate goal
    - Backup power is a first step to continuous power
    - Off-road mobility is a first step to on-road mobility
    - Lower cost hydrogen production (from natural gas) will lead to “green” hydrogen

Summary (Cont'd)

- Include backup power applications in Self-Generation Program
- Use funds wisely: why fund a demonstration for an application that is a decade away (e.g. residential continuous power); propose that Commission is better off funding less costly R&D work in this area. Fund demonstrations that are near commercial.
  - This may warrant consideration of novel power architectures, such as lower cost, fuel cell/battery dominant hybrid systems

Fuel cell, battery dominant, plug-in hybrid bus

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Thank you!

Kevin M. Harris
Hydrogenics Corporation
kharris@hydrogenics.com
Ph: 661-253-2593

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...Powering Change

Hydrogenics Mission

Changing Power…

Through the development and commercialization of clean Hydrogen and Fuel Cell Technology we are changing the way the world looks at making and using energy and power

…Powering Change

We do this by setting a world-leading pace in our sector through the application of innovation and strategic partnerships that engage a wide range of stakeholders who share our vision

Business Units and Markets

OnSite Generation

- Industrial Hydrogen
- Refueling Stations

Power Systems

- Backup Power
- Light Mobility

Test Systems

- Test Stations
- Diagnostics
- Test Services

HyPM Fuel Cells Power Modules

- Broad Range of Products: 8, 12, 16, 65 kW
- Start-stop cycles demonstrated* >6000hrs
- Efficiency: 48% - 56%
- Compact: 156L for HyPM 12 (11 L/kW)
- Weight: 95 kg for HyPM 12
- Low Pressure System: <20kPa
- CANBus Communication System
- Voltage Input for Startup*: 12V

HyPM 8

HyPM 12

HyPM 65

* Refers to HyPM 12 test modules

HyPM® Fuel Cell Power Pack

Fully Integrated Solutions for
End User Applications

HyPM Power Module

Thermal Management

Power Conditioning

Shown above: Fuel Cell Power Pack configured for battery replacement in Class 1 Forklifts

Energy and Hydrogen Storage

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Focus on Commercial Markets…

… but continue to support Military & Pre-Commercial Opportunities

Core Technology Platform

HyPM 500 Series

Integrated into complete solutions

Increased Product Development

Increased Marketing & Sales

End-Users in Three Target Commercial Markets

Sold to meet the needs of…

Military and Pre-Commercial Markets

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Fuel Cell Applications

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Fuel Cell Applications

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Fuel Cell Applications

On the Bright Side…

- The drivers behind a hydrogen economy are increasing
- Many sectors are positively contributing:
  - energy, merchant gas, utilities, automotive, governments, technology
- Investment involvement is improving

Progress

- Costs are decreasing
- System complexity is decreasing → reliability is increasing
- Durability is increasing
- OEM relationships are increasing
- Government based incentives are being established
- Work on codes and standards continue
- Marketing is becoming more focused